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ABSTRACT

The reading achievement test performance of 180 sixth grade students in contrasting reading programs was examined. One program (Matteson) was an explicitly sequenced, behaviorally oriented skills program: the other (Scott Foresman) placed more emphasis on rich language experience and less emphasis on specific skill development. An aptitude-treatment interaction was found: higher ability students in the Scott Foresman program outperformed those in the Matteson program, while the lower ability students in the Matteson program scored higher than those in the Scott Foresman Program. (Author/RL)

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CENTER FOR THE STUDY OF READING

Technical Report No. 174

ACHIEVEMENT OUTCOMES OF TWO READING PROGRAMS: AN INSTANCE OF APTITUDE-TREATMENT INTERACTION

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Abstract

The reading achievement test performance of sixth-grade students in contrasting reading programs was examined. One program (Matteson) is an explicitly sequenced, behaviorally oriented skills program: the other (Scott Foresman) places more emphasis on rich language experience, and less on specific skill development. An aptitude-treatment interaction was found: higher ability students in the Scott Foresman program outperformed those in the Matteson program, while lower ability students in the Matteson program scored higher than those in Scott Foresman. Explanations and implications are discussed.

Achievement Outcomes of Two Reading Programs: An Instance of Aptitude-Treatment Interaction

Recently, several educational researchers have been attempting to examine a phenomenon that teachers have observed for some time: the fact that different instructional programs have quite different effects on students of differing aptitudes. Some time ago, Cronbach (1957) argued for the coalition of correlational and experimental psychology through the study of interactions between instructional treatments and student aptitudes. Such interactions have been termed by Cronbach and others aptitude-treatment interactions (ATI). Cronbach and Snow (1977) have defined aptitude and treatment in very broad terms. Aptitude can refer to personality and strategy preferences as well as to ability measures; treatment covers any aspect of the instructional environment, including such variables as pace and method of presentation, as well as teacher characteristics.

Cronbach and Snow's (1977) review of ATI research shows, however, that a combination of trivially brief treatments, inadequate design and analysis techniques, and general uncertainty about how to study the phenomenon have all led to many disappointingly doubtful and inconsistent results. There were, nonetheless, enough clear instances of ATI for Cronbach and Snow to conclude that more careful and relevant work could yield significant findings for researchers, curriculum designers, and educational policy makers. To enhance future research, Cronbach and

Snow suggested three issues for concentration: (a) the examination of the most plausible ATI hypotheses in long-duration, real-school studies, (b) the development of designs and analytic methods capable of handling such complex studies, and (c) the development of a laboratory science for the analysis of aptitude tests and learning tasks, and the ATI constructs based on them.

The goal of the present study is to contribute to the first-mentioned effort, that is, the examination of a plausible ATI in a real-school setting, as a result of long-term instructional programs. The programs to be examined are two fourth-grade to sixth-grade reading programs. The aptitude construct is represented by two distinct scores--an overall (verbal plus nonverbal) intelligence test score, and a reading pretest score, given two years prior to the testing session, immediately prior to the students' entry into the separate reading program.

The ATI hypothesis to be considered may be stated in general terms as follows: Instructional methods differ in the amount of information processing effort they demand of, or provide for, the learner. The greater the information processing burden on the learner in a given program, the more the high-ability student benefits, and the less the low-ability student gains. Conversely, the more the instructional format relieves the learner of difficult processing, the smaller is the difference in the performance of high- versus low-ability students (Snow, 1978). This issue has often appeared in educational debate in varying terminology--the optimal degree of structure, the benefits of discovery versus traditional versus programmed methods, and so on. All these terms, including

information-processing burden, gloss over the issue of precisely where the critical differences lie. They may reside largely in differences in the degree to which strategies are trained, sequenced, or accessed for particular tasks, or in the degree of explicitness of expected responses, or in the amount of clear signaling of relevant knowledge.

While there has been little progress in analyzing how the above factors contribute to the information-processing burden, there has been some agreement across a range of studies that this global instructional characteristic does affect students of different aptitudes differently. This effect has been shown to hold in the teaching of arithmetic procedures (Thiele, 1938) and introductory probability theory (Greeno & Mayer, Note 1). In both cases, "meaningful" or discovery methods were found to enhance the performance of high-ability students, while drill and rule-learning methods led to improved performance among lower ability students. On a broader scale, Sharps (cited in Cronbach & Snow, 1977) examined differences for fifth-grade students on a number of achievement measures arising from two long-term programs: a conventional teaching program and an Individually Prescribed Interaction (IPI) program. The IPI program entailed pretests, specified objectives and sequences leading to these objectives, with frequent mini-tests for feedback and branching purposes. The results showed a strong interaction between verbal ability plus achievement and the two instructional programs. The general ATI hypothesis was confirmed: for the lower ability students, the IPI method was more beneficial; for the higher ability students, IPI was less effective than the traditional program.

As Cronbach and Snow (1977) emphasized, the area of reading has received a lot of attention from researchers, but most comparisons of reading programs have not been designed to examine long-term ATI effects. There are few clear findings. Bond and Dykstra (1967) reported results from the massive Co-operative Reading Program study of first-grade reading programs. They reported no discernible ATI effects. Some questions about sample groupings and data analysis, however, led Cronbach and Snow and Lo (cited in Cronbach & Snow, 1977) to reanalyze portions of the data. In these reanalyses, some ATI effects were found. Language-experience programs, for instance, led to more striking differences between high- and low-ability girls than did whole-word approaches. The fact that this relation did not hold for boys illustrates Cronbach and Snow's conclusion that, while several results were suggestive of ATI, the effects were by no means convincing.

The aim of this study is to examine the possibility of ATI, at a broad level, in two reading programs. Current programs differ in the degree to which they explicitly sequence and structure tasks. Some programs explicitly train, sequence, and maintain skills and knowledge such as letter-sound correspondence, new word meanings, disambiguation skills, cross-sentence integration, and inferencing. We might hypothesize, then, that in the comparison of two long-term reading programs, lower ability students will show better performance in the program which provides more explicit and detailed direction than they will in less directive programs. Higher ability students will show the reverse trend, if the hypothesis holds.

Method

Subjects

The students tested comprised all those sixth-graders (N = 180) in a large school district in the greater Chicago area who had been in their present reading program for two years or longer. The area is, for the most part, middle-class residential. There were 96 students in the Matteson program and 84 in the Scott-Foresman program.

The Reading Programs

The Matteson Four-Dimensional Reading Project. The Matteson Program is a behaviorally oriented skills program. As stated in the Teacher's Guide (Schlenker, 1978) the program includes: (a) a list of behavioral objectives for grades three through eight, (b) individualized learning packages covering 108 behavioral objectives in the major skill areas (word recognition, vocabulary development, literal comprehension, interpretive comprehension, analytical comprehension, study skills, and composition), (c) criterion-referenced pretests, posttests, and subskill tests for each level of the program, (d) individual pupil progress charts and classroom progress charts, and (e) commercial materials to be used with learning cards.

The program entails branching and repetitions when test scores dictate such. The behavioral objectives are often stated in quantitative terms. Some examples are:

1. Word discrimination: Given a list of 44 Dolch sight words, the student will pronounce correctly the words.

2. (47) Analogy: Given a pair of words that are analogous, the student will identify correctly another pair of words that are related in the same way.

The Matteson program is strictly sequenced and closely monitored. In Snow's (1977) terms, the program seems to be one which, relative to other programs, relieves the learner of much difficult and unspecified processing. In theory at least, subskills are mastered before dependent higher-order skills are developed.

The Scott Foresman Reading System. While the Matteson program includes in its overview some general suggestions for free reading and supplemental language experiences, the Scott Foresman program has as its central goal the student's interaction with the concepts and ideas put forth by an author. The emphasis is on rich language experience and frequent discussions aimed at the literal and inferential significance of discourse. A paragraph from the introduction to the Teacher's Guide to Level 13 (Windows 1972) gives the flavor of the place of specific skills in this program:

> For the few pupils who may need detailed guidance as they read, suggestions are given within particular selections. Other guidance points up a specific skill or gives help with concepts and words or phrases that may be unfamiliar. The latter might be used with pupils who read independently as well as those who read under guidance. (p. 1)

After each passage, students complete test questions which relate to vocabulary and literal and inferential comprehension, but the program itself contains no strict sequencing or criteria for progress.

Two points need to be made here. First, as already stated, both programs entail both skill building and rich language experience. It is at the level of the central goals of the programs that clearly differing emphases can be detected. These differences relate to sequencing, feedback to student and teacher, and degree of specificity of the skill and the expected performance. It is these aspects which, it is hypothesized, characterize the difference in processing burden on the learner. Second, the teacher's guides are not a direct measure of what actually goes on in the classrooms when these programs are used. It is possible, though unlikely, that some teachers use the Scott Foresman program in a strictly sequenced and monitored fashion, making very explicit the goals in each section. Similarly, the Matteson program could be used merely as a remedial adjunct to an experientially oriented program. These modifications would, however, be contrary to the spirit and the letter of the guides. In addition, we were assured that the teachers in this district used the programs as the guides indicate.

The Ability and Reading Tests

The students' verbal and non-verbal abilities were measured with the elementary level, form R of the Educational Development Series (Scholastic Testing Service, 1976). Form R included non-verbal (figure matching) and verbal (word knowledge and use) measures of ability.

The reading tests given were the appropriate level reading subscales of the Educational Development Series. The pretest used was that administered to the students at the end of grade four. The posttest was

the appropriate form administered at the end of grade six to the same 180 students. The reading tests entailed literal, inferential, and main idea comprehension questions, in multiple choice format, following brief passages and poems. The passages consisted of narrative and expository discourse. In the sixth-grade test, for instance, there were five passages (two narrative, three expository) and one poem and 50 multiple choice questions in all.

Results

Before presenting the major findings concerning the effects of these two programs, the initial comparability of the two groups needs to be established, since, for some unexplained reasons, the interaction between aptitude and program might have existed at the point of entry to the program. Any interactions between aptitude and program on posttests would, in this case, be artifactual.

Means and standard deviations for the two groups are presented in Table 1. The only contrasting point is the slightly larger standard

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Insert Table 1 about here.

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deviation on ability scores among the Scott-Foresman students. It is also important to establish the similarity of correlations among the measures for the two groups. Tables 2 and 3 show that, with two exceptions, these correlations do not differ significantly. The two exceptions are the

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Insert Tables 2 and 3 about here.

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correlations between pretest and number of years in the programs ($z = 3.539$), and the correlations between posttest and ability ($z = 2.197$). We have no neat explanation of the first difference. The second, however, strongly suggests an interaction between aptitude and programs on posttest scores.

Since there was a slight difference in ability variances for the two groups, the regression slopes for ability on pretest scores were computed. For the Matteson group, the slope was .57 and, for the Scott-Foresman group, it was .54. This difference was judged to be trivial. Any interaction between ability and program on posttest scores could not be attributable to an interaction existing prior to the instructional treatment.

Tables 2 and 3 show that sex did not correlate highly with any other measures. In a regression analysis, sex was found not to be a significant predictor. It did not interact significantly with course or ability, nor were there any significantly different correlations between the measures when the coefficients were computed separately for boys and girls. Thus sex was dropped from the remaining analyses.

The aptitude-program interaction was confirmed using multiple regression analysis. Posttest scores were predicted for each reading group separately from the equations presented in Tables 4 and 5. It can be

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Insert Tables 4 and 5 about here.

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seen that, for the Matteson students, posttest is predicted by both pretest and ability. For the Scott-Foresman group, on the other hand, the only significant predictor of posttest performance is ability.

A significant aptitude-treatment interaction was found and is presented in Tables 6 and 7. From Table 6 it can be seen that ability, pretest, and the course by ability interaction contributed significantly to the prediction of posttest scores. In total, over 50% of the variance on the posttest

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Insert Tables 6 and 7 about here.

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was predicted. Of particular interest here is the course by ability interaction. Table 7 indicates this effect. Mid-points along both the ability and pretest continua were selected, and the predicted posttest scores for Matteson (M) and Scott Foresman (SF) students are presented for purposes of illustration. These predicted scores were computed using the equations presented in Tables 4 and 5. It is the case that lower-ability students who perform as well as or better than their ability scores would predict on the pretest, perform better in the Matteson program. It is equally clear that higher-ability students who perform as well as or worse than their ability scores would predict, perform better in the Scott Foresman program. Interestingly, the medium-ability student who performs poorly on the fourth-grade pretest is predicted to do better in the Scott Foresman program, while the medium-ability student who performs particularly well on the pretest is predicted to do better in the Matteson program.

Discussion

The hypothesis of interaction between ability and instructional condition is confirmed. Lower ability students benefited from the Matteson program, higher ability students from the Scott Foresman program. We infer that this finding represents an affirmation of the general hypothesis that a program which relieves the learner of much of the burden of processing, by assuming the acquisition, maintenance, and checking of important subskills, will be of greater benefit to lower ability students than will a less strictly organized program emphasizing higher-order skills and more conceptual interaction with reading materials. Higher ability students, on the other hand, will benefit more from the latter program. Thus, as Snow (1977) suggested, a highly structured program tends to "flatten out" the relationship between performance and ability.

Some speculation about why this occurs is called for. An explanation may lie in the construct of "metacognition" that has been developed in recent theory (see Flavell, 1976). It has been suggested that ability test performance does not relate only to the amount of information possessed by a student but also to the student's ability to organize knowledge and skills. Sensitivity to one's errors while reading, knowing when to use certain strategies to enhance recall, locating gaps in knowledge while studying, and so on, are all executive processes rather than knowledge about reading per se.

If a large portion of the differences between high- and low-ability students is thought to entail deficits in executive functions, then a

program that takes on itself responsibility for many of these functions would lessen the differences between students of different abilities. The low-ability students would be helped, and it may be that higher ability students, who have developed their own ways of organizing their reading and learning, find the explicit and ubiquitous organizational aspects of the highly structured program an interference. A program which takes such executive skills for granted and concentrates on language enrichment enhances the learning of the high-ability students and deprives the lower ability students of the organizational supports they need.

Some predictable qualifications need to be made to these interpretations. First, while the sample is large, there may be something distinctive about this district or these students which would detract from the replicability of such a result. Second, the notion of aptitude needs closer examination. There may be certain skills not assessed by the pretests which render the samples different in an important way at their time of entrance into these instructional programs. Third, to reiterate an earlier point, we need to know more precisely how strictly the program specifications were adhered to. There may have been some mixing of techniques along an "experience-based/skill-based" continuum. These qualifications amount to suggestions for further research to clarify and detail the relationships found here.

These findings have implications for reading educators: Both types of programs should be available to a student, and initial placement should depend upon entering ability. The obvious danger of such a policy is

that this placement can become incarceration. This can be avoided by careful and frequent monitoring of reading performance and flexibility in the movement of students between programs.

Researchers and evaluators of reading instruction will also find implications in these results. Much research on reading instruction is of the horse-race sort (see, for instance, Bowers, 1974, and the review by Samuels & Schachter, 1978). The overall means of two programs are compared. These results strongly suggest the soundness of Cronbach and Snow's (1977) advice to regard separarely the performance of students of different aptitudes.

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Table 1

Means and Standard Deviations

	Matteson Group N = 96		Scott-Foresman Group N = 84	
	M	SD	M	SD
Ability	114.61	14.42	113.74	15.27
Pretest	23.27	13.15	24.92	12.99
Posttest	30.53	10.01	31.02	10.21

Table 2

Correlations for the Matteson Group

	1 Y.I.P.	2 Sex	3 Ability	4 Posttest	5 Pretest
Years in Program					
Sex	.04				
Ability	.10	-.03			
Posttest	.10	.04	.58		
Pretest	.20	-.02	.62	.61	

Table 3

Correlations for the Scott-Foresman Group

	1 Y.I.P.	2 Sex	3 Ability	4 Posttest	5 Pretest
Years in Program					
Sex	.00				
Ability	.33	.18			
Posttest	.18	.20	.76		
Pretest	.63	.13	.64	.50	

Table 4

Regression Weights, Partitioning of Variance,

and Significance Tests for Posttest

(Matteson, N = 96)

Variable	B Weight	% Variance	F
Ability	.35	34.08	55.81*
Pretest (gr. 4)	.31	10.13	16.59*
Years in Program	5.62	.02	< 1
Y.I.P. x Ability	-.05	.13	< 1
Intercept	-16.39		
Residual		55.56	

R = .666; $F(4,91)$ = 18.14; p < .01

*p < .01

Table 5

Regression Weights, Partitioning of Variance,

and Significance Tests for Posttest

(Scott-Foresman, $N = 84$)

Variable	B Weight	% Variance	F
Ability	.28	57.16	108.57*
Pretest (gr. 4)	.08	.03	< 1
Years in Program	-11.44	1.08	2.05
Y.I.P. x Ability	.07	.14	< 1
Intercept	5.77		
Residual		41.59	

$R = .764$; $F(4,79) = 27.74$; $p < .01$

*$p < .01$

Table 6

Regression Weights, Partitioning of Variance, and Significance Tests for Posttest (N = 180)

Variable	B Weight	% Variance	F
Ability	.23	44.36	155.33*
Pretest (gr. 4)	.32	3.29	11.52*
Years in Program	-1.05	.12	< 1
Course	-22.48	.22	< 1
Course x Pretest	-.28	.33	1.16
Course x Ability	.27	2.27	7.95*
Intercept	-.47		
Residual		49.41	

$R = .711$; $F(6, 173) = 29.53$; $p < .01$

*$p < .01$

Table 7

Predicted Means for Students at Various Combinations

of Pretest and Ability in the Two Reading Programs

Pretest Grade 4	Verbal and Non-Verbal Ability Combined		
	90	110	130
12	22.00[a](M)[b] 19.39(SF)[c]	26.44(M) 28.80(SF)	This combination not likely to occur.
24	25.74(M) 20.38(SF)	30.18(M) 29.80(SF)	34.62(M) 39.22(SF)
36	This combination not likely to occur.	33.92(M) 30.80(SF)	38.36(M) 40.21(SF)

Note. Figures are based on the student with the average stay in either program: 2.6 years.

[a] Standard error of estimate (Sest) was 7.47 for the Matteson group and 6.59 for the Scott-Foresman group.

[b] Matteson

[c] Scott-Foresman

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